BIOAg Project Progress Report

Title: Grafting vegetables for resistance to *Verticillium* wilt.

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Key words:
Grafting, *Verticillium* wilt, tomato, eggplant, watermelon, rootstock

Abstract:
Tomato, eggplant and watermelon in Washington can be significantly impacted by *Verticillium* wilt, a soil-borne disease common throughout Washington. *Verticillium* microsclerotia are known to persist in soil for up to 13 years. Symptoms impact plants later in development after most production costs have been incurred, resulting in a 25-100% crop loss in some years even in conventional systems where ground has been fumigated prior to planting. Grafting vegetable crops onto resistant rootstock is a cultural control method that provides an organic and sustainable alternative to soil fumigation. Grafting has been used successfully in Asia for nearly 100 years, but is only now being adopted in the U.S. Grafting adds to production costs but is cost effective for high-value crops such as tomato, eggplant and watermelon when disease pressure is high. In Washington, both conventional and organic growers have expressed interest in grafting as an IPM strategy. This project examines the effects of grafting on disease resistance of eggplant, heirloom tomato, and watermelon in greenhouse and open-field production in Washington and Oregon via on-farm and on-station trials. New extension publications outlining low-cost grafting methods will be developed for growers looking for sustainable alternatives to chemical disease management strategies. This project addresses the BIOAg priority area No. 1 by investigating a biologically intensive approach to disease management.

Project Description:
This study is being conducted at WSU Mount Vernon NWREC and in cooperating grower’s fields with high *Verticillium* wilt pressure. In Year 1 (2010), resistant commercial rootstocks and
seeding dates were identified, and grafting techniques tested and selected for each crop. Field soil was sampled and assayed for *Verticillium dahliae*. Field sites with high disease pressure were identified and trials were carried out at 2 station and 2 on-farm sites to test grafted tomato, eggplant and watermelon. Field sites were WSU Mount Vernon NWREC (tomato, eggplant, watermelon), Schreiber and Sons Farm, Eltopia, WA (tomato, eggplant), OSU Hermiston REC (watermelon), and Pollock & Sons Farm, Hermiston, OR (watermelon). Research design at all sites was a randomized complete block with three or five replications (varied due to plant availability). Treatments in each study were: ‘Cherokee Purple’ (CP) heirloom tomato grafted onto ‘Maxifort’ and ‘Beaufort’ rootstocks; ‘Epic’ eggplant grafted onto ‘Beaufort’ and *Solanum aethiopicum* rootstock; ‘Crisp’N Sweet’ triploid watermelon grafted on ‘Strong Tosa’ and ‘Emphasis’ rootstocks; and self-grafted and non-grafted control for each crop. Plants were grafted in May and transplanted to the field in early June. At all sites, plant health and vigor were rated biweekly in the field beginning July 7, and plants were rated three times during the growing season for disease incidence and severity. Stem diameter of watermelons was measured three to four times between July 19 and September 2. *Verticillium* wilt symptoms were first observed in the Mount Vernon NWREC watermelon plots on August 12 and thereafter was monitored weekly through September 23. Watermelon was harvested August 3, August 17, and September 3, 2010. Plant height for tomato and eggplant were measured three times during the growing season and yield (fruit number and weight) was measured weekly. Late blight (*Phytophthora infestans*) was observed in the Mount Vernon NWREC tomato plots on August 20, an organic fungicide was applied weekly to impede late blight development in research plots, and disease was monitored twice weekly through September 21. Tomato, eggplant and watermelon fruit quality was measured for soluble solids (Brix), firmness and lycopene (tomato and watermelon only). In late August, symptomatic plants were assayed for *Verticillium* wilt in the laboratory, and *Verticillium dahliae* was isolated from some samples. Inoculum has been generated from pathogen isolates. In Year 2 (2011), we will conduct a greenhouse study to confirm isolate pathogenicity (Koch’s postulates). We tested three healing chambers and determined an effective design for western Washington. We will repeat field experiments in fields with high disease pressure at WSU Mount Vernon NWREC and Eltopia, WA.

Preliminary results were presented in Fall 2010 at the WSU Mount Vernon NWREC seminar series, the PNVA meeting, and the International Plant Propagators' Society North American Western Region Annual Meeting. We posted a new web page on vegetable on my program website, [http://vegetables.wsu.edu](http://vegetables.wsu.edu). A hands-on vegetable grafting workshop for growers and the nursery industry will be offered at WSU Mount Vernon NWREC in spring 2011. This project will be highlighted at the Tilth Producers of Washington Farm Walk at WSU Mount Vernon NWREC in June 2011. Final results from this study will be submitted for publication to HortScience and HortTechnology, will be presented at the Department of Horticulture and Landscape Architecture graduate student seminar series, and will be submitted for presentation at the Tilth Growers Conference. At the completion of this study, Extension factsheets and potentially a manual for vegetable grafting will be developed. Expected outcomes from this project include: 1.) An effective organic disease control method for *Verticillium* wilt that can be utilized by both organic and conventional growers; 2.) An expansion of crop options in the area due to effective disease control; and 3.) The opportunity for new agricultural industries to develop – the production of rootstocks and grafted transplants.
**OUTPUTS**

**Work Completed:** Seeding times for rootstock and scion varieties were determined for optimum size for grafting. A low-cost effective healing chamber design was identified for northwestern Washington. Soil samples were assayed for *Verticillium* and field sites with high disease pressure were selected for field experiments in 2010 and 2011. Tomato, eggplant and watermelon were grafted onto *Verticillium* wilt resistant rootstock and tested at 2 station and 2 on-farm sites in 2010. Data were collected and analyzed, preliminary findings were presented, and reports are being prepared. Field experiments of grafted tomato, eggplant and watermelon will be repeated in 2011 at WSU Mount Vernon NWREC and Schreiber and Sons in Eltopia, WA, where disease pressure was highest based on 2010 results.

**Publications, Handouts, Other Text & Web Products:**


**Outreach & Education Activities:**


**IMPACTS**

**Short-Term:** We will establish successful grafting techniques for tomato, eggplant and watermelon and make this information available to growers and suppliers. Currently, there are several guidelines available that contain conflicting information.

**Intermediate-Term:** Growers will view grafted vegetables as a viable alternative to manage *Verticillium* wilt by the end of 2011. Seed and transplant suppliers will have rootstocks and

**Long-Term:** By 2015 fumigation will be used less frequently by conventional growers to control *Verticillium* in watermelon and eggplant crops; organic growers will recognize *Verticillium* wilt symptoms and utilize appropriate control practices including grafting and rotation (if possible); and effective, affordable and available rootstocks will be identified for use in grafted eggplant, watermelon and tomatoes in Washington.

**ADDITIONAL FUNDING SECURED**

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**GRADUATE STUDENT FUNDED**

Sacha Johnson, MS, WSU, Horticulture and Landscape Architecture, Jan. 2010 – May 2012

**RECOMMENDATIONS FOR FUTURE RESEARCH**

1. Identify new disease resistant rootstocks and investigate potential for seed production in WA.
2. Investigate vegetable grafting as an alternative method to fumigation for disease control for tomato, eggplant and watermelon production in WA.
3. Evaluate opportunities and costs for commercial grafted vegetable transplant production in WA.
4. Investigate use of grafted transplants in greenhouse production in WA.